A CASE STUDY ON THE REHABILITATION OF AN OLD AFRICAN HEAVY HAUL FREIGHT LINE

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ABSTRACT: In many countries, old railways have to be renewed in order to fulfil modern quality requirements, either related to higher travel speeds, to greater axle loads or to increased capacity. Preferably, such renewal works should be carried out in an economical and environmental sustainable process, taking into account the existing materials and the *in situ* conditions of the structure.
This paper presents studies carried out in order to establish track structural configurations for the rehabilitation of a long old international railway line in Africa that is expected to accommodate heavy freight traffic in the near future.
The visual inspection performed throughout the line, the analysis of the characteristics of the existing superstructure and the substructure survey made it possible to identify the thickness of the layers, soils characteristics and to evaluate stiffness of the track bed.
An experimental study was carried out in a deactivated rail stretch in order to assess the feasibility of different track structural configurations, in what regarded costs and construction processes. Results of Ground Penetrating Radar (GPR) surveys, Plate Load Tests (PLT) and Falling Weight Deflectometer (FWD) tests performed on the experimental site are also presented herein.
A numerical modelling analysis of the different structural configurations that were tested in the experimental site is also presented. Stress and deformation results are analysed and compared.

Keywords: railway track rehabilitation, sustainable transportation, experimental field works, track numerical modelling.

1 INTRODUCTION

The modernization of under operation railway lines usually requires renewal of the track superstructure as well as improving its substructure. This process generally consists in replacing track components or modifying its characteristics in order to achieve increased track performance. It may include the replacement of the superstructure elements, the construction of reinforcement layers or even replacement or improvement of foundation soils.
The main differences between a new construction project and a renewal project of a railway infrastructure are related to (Fortunato *et al.*, 2001): i) the concern to maintain, as much as possible, the existing structure; ii) the need to reduce disturbances on the railway line operation during renewal; iii) the physical constraints imposed by existing structures; iv) the additional effort to adopt some of the construction techniques commonly used when it comes to building a new track, for example improving the subgrade soils; v) longitudinal and transversal inhomogeneity of the materials present in the substructure, particularly when no appropriate maintenance and rehabilitation works were undertaken; vi) the maintenance of high safety standards during the renewal works.
The renewal process, besides considering the abovementioned aspects, should be based on characterisation studies of the physical and mechanical properties of existing track components and layers. In fact, this aspect is absolutely necessary in order to find efficient track configurations both in structural terms (regarding the railway track layers and the superstructure) and in terms of complementary works, such as drainage structures.
The evaluation of physical and mechanical characteristics of the structure and its components can be made using different methods, depending on the accessibility to the railway line. In what concerns the subgrade, it is common practice to characterize the geo-materials, determining intrinsic parameters and water content and degree of compaction.
In old railway tracks, particularly those in which there is no sub-ballast layer, it is often observed a layer of fouled ballast on the top of the subgrade. This contamination with fine particles is due to different causes, mainly resulting from: i) “pumping” of fine material of the foundation due to cyclic loading from passing trains; ii) degradation of ballast particles when the aggregate has low resistance to abrasion and fragmentation.
There are some technical, economic and environmental advantages in maintaining the fouled ballast layer in the support track under the new reinforcement layers (Fortunato *et al.*, 2010). These advantages are related to the higher stiffness of that layer and the reduction in supply, deposit and